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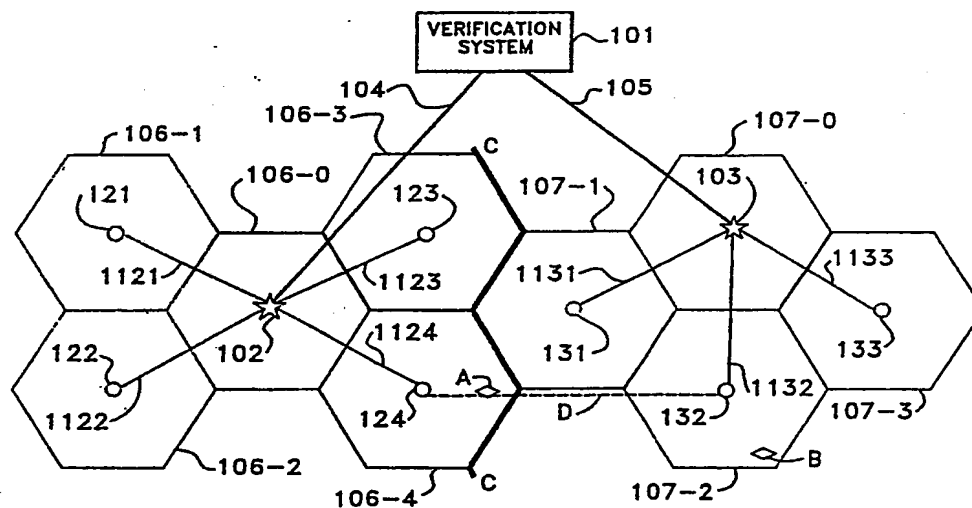
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(54) Title: **APPARATUS FOR DETECTING AND PREVENTING SUBSCRIBER NUMBER TUMBLING IN A CELLULAR MOBILE TELEPHONE SYSTEM**



(57) Abstract

For each roaming mobile subscriber unit (A) call origination, the serving cellular mobile telephone system (102) transmits a roaming subscriber validation request to the roamer verification system (101), which scans the subscriber status database (317) to determine whether this roaming mobile subscriber unit (A) is a valid user. If a positive validation is not made, an inquiry is transmitted to the home switch (103) of the roaming subscriber to obtain a positive subscriber validation. The call origination is not processed until a positive subscriber validation is received from either the subscriber status database (317) or the home switch (103). This process eliminates the use of bogus subscriber numbers, such as found in tumbling subscriber units wherein a new subscriber number is used for each successive call origination to avoid detection of the bogus subscriber unit.

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**APPARATUS FOR DETECTING AND PREVENTING
SUBSCRIBER NUMBER TUMBLING IN A
CELLULAR MOBILE TELEPHONE SYSTEM**

FIELD OF THE INVENTION

5 This invention relates to cellular mobile telephone systems and, in particular, to apparatus that detects attempts by an unauthorized user to use bogus subscriber numbers, obtained by tumbling subscriber numbers, to originate unauthorized calls.

10 PROBLEM

It is a problem in the field of cellular mobile telephone systems to prevent call initiations by unauthorized users who attempt to fraudulently access the cellular mobile telephone system. There are numerous methods used to originate unauthorized calls in cellular mobile telephone systems and many of these methods are difficult to detect and prevent due to the mobile nature of the subscriber station set. One method of fraudulent access is the use of subscriber number tumbling to obtain unauthorized access to the cellular mobile telephone system. Subscriber number tumbling is accomplished by an unauthorized user programming the cellular telephone station set to tumble subscriber numbers in order to deceive the cellular mobile telephone system into providing call services to the unauthorized user. Existing cellular

mobile telephone systems can not distinguish between valid and fraudulent subscriber numbers in a service area remote from the subscriber's home switch due to the fact that the subscriber station sets are mobile and are only identified to the cellular telephone system by subscriber number and unit identification number. On existing cellular telephone systems, the roaming subscriber validation process is not initiated until the call is completed and all call detail records are complete, including call duration. The serving cellular telephone switch then requests that the subscriber's home switch validate the authorization of the roaming subscriber to receive the requested service. Service can be denied to a fraudulent tumbled telephone number only when the fraud is detected and the fraudulent unit identified. However, the tumbling process is successful since a new subscriber number is used for each call initiation by the unauthorized user. There presently exists no system that can provide this fraudulent unit detection and service theft prevention capability since call validation occurs after the call is completed and the tumbled number is not reused by the bogus subscriber unit.

SOLUTION

The above described problems are solved and a technical advance achieved in the field by the apparatus for detecting and preventing subscriber number tumbling in a cellular mobile telephone system. This apparatus operates to verify the authorization of a subscriber number to be used for roaming by scanning a central database of valid subscriber numbers to positively verify the calling mobile subscriber unit. If this unit is not identified in this database the apparatus verifies the authorization of the calling mobile subscriber unit in the cellular mobile telephone system by routing a roamer verification request directly to the home switch of the subscriber. The failure of the home switch to positively validate the roaming subscriber is typically indicative of attempted fraudulent access to the cellular mobile telephone system. In response to the lack of a positive roamer validation, this apparatus identifies the roaming subscriber as a bogus subscriber unit. Once this bogus subscriber unit is identified, the call origination by the bogus subscriber unit is denied and further theft of service prevented. This apparatus can block tumbled subscriber number calls on a per call origination basis, regardless of the tumbling algorithms used.

The detection of a bogus subscriber unit is accomplished by routing data relating to a roaming subscriber call origination to a central subscriber verification system that maintains records of all the subscribers presently active or authorized to originate and receive calls in the particular cellular mobile telephone service area. The call origination data is compared to the subscriber status data in the

user database to obtain positive verification of the mobile subscriber unit. Rather than simply relying on the data that is stored in the user database to identify authorized roaming subscriber numbers, in response to positively validate the roaming subscriber number, this apparatus transmits a query to the home switch of the roaming subscriber to request positive validation of the roaming subscriber. The completion of the call origination is delayed by the serving cellular switch until a positive roamer verification is received from the roaming subscriber's home switch. The central subscriber validation system maintains a database that identifies the correspondence between a roaming subscriber number and the home switch of that subscriber number. By providing a data connection to the home switch on each roaming subscriber call origination to validate the roaming subscriber's identity, calling party authorization can be determined on a per call basis. The call origination is not serviced until a positive verification is received from the home switch or database authorizing the roaming subscriber call origination. By verifying roaming subscriber number on a real-time, per call origination basis, this system thwarts all methods of subscriber number tumbling.

DETAILED DESCRIPTION OF THE DRAWING

Figure 1 illustrates in block diagram form the architecture of a typical cellular mobile telephone system;

5 Figures 2 and 3 illustrate in block diagram form architectural details of the apparatus of the present invention;

10 Figures 4 - 6 illustrate in flow diagram form the operational steps taken by this apparatus to detect subscriber units that are tumbled subscriber numbers.

DETAILED DESCRIPTION

Figure 1 illustrates a typical cellular mobile telephone system that includes a plurality of Mobile Telephone Switching Offices (MTSO) 102, 103, each of which is connected via communication facilities 1121-1124, 1131-1133 to a plurality of cell site transmitters 121-124, 131-133. Mobile subscriber units A, B within each cell site 106, 107 can initiate or receive telephone calls via radio frequency communication with transceiver apparatus 121-124, 131-133 located in their corresponding cell site 106, 107. A plurality of cell sites 106 are interconnected with a designated Mobile Telephone Switching Office 102 which serves to interconnect the transceivers 121-124 in the various cell sites 106 served by the Mobile Telephone Switching Office 102 with the Public Switched Telephone Network (PTSN) (not shown) to access other Mobile Telephone Switching Offices as well as conventional telephone apparatus.

The range of a particular cellular service is determined by the geographic location of the cell sites. In addition, cellular mobile telephone systems are not connected on a nationwide basis. Rather, the industry consists of many distinct geographical regions that service a specific "home" base of subscribers. For example, in Figure 1 the bold line C-C denotes a boundary between two cellular regions, with Mobile Telephone Switching Office 102 being located in a first of these regions and Mobile Telephone Switching Office 103 being located in a second juxtaposed region. When cellular subscribers leave their home geographical region they become "roamers". When a roaming subscriber places a cellular telephone call, the foreign system that

provides service has no way of determining if this roamer is a valid subscriber or a bogus subscriber, since this information is located in the roamer's home system. Obtaining the information from the home switch, and notifying the foreign system of the roamer status is the purpose of the roamer verification system, illustrated in Figure 1. The cellular mobile telephone system generally includes apparatus to maintain data concerning each subscriber authorized to initiate and receive calls within the cellular mobile telephone network. These subscribers include subscribers for whom the local Mobile Telephone Switching Office 102 is their base switch and roamers who are subscribers from other service areas who have entered or are passing through this service area. The subscriber validation apparatus can be included in each of the Mobile Telephone Switching Offices 102, 103 and coordinated therebetween or may reside in a central clearinghouse location (roamer Verification System 101) to serve a plurality of the Mobile Telephone Switching Office 102, 103. For the purpose of this description, assume that a subscriber validation apparatus is located in roamer verification system 101 which is interconnected via data link or dial up communication facilities 104, 105 with the plurality of Mobile Telephone Switching Offices 102, 103 illustrated in Figure 1 as well as others not shown thereon. The apparatus illustrated in Figure 1, are well known in the cellular mobile telephone industry and represent the basic systems within which the apparatus of the present invention cooperatively operates.

The cellular mobile telephone network operates much as a conventional land line telephone switching

network with the exception that the subscriber units A, B are mobile and must therefore include a method of uniquely identifying each mobile subscriber unit operational within each service area. Furthermore, these mobile subscriber units A, B are typically in motion during the call connection and the communication between the mobile subscriber unit A and the cell site transmitters 121-124 must be dynamically configured in response to the movements of the particular mobile subscriber unit A. In order to uniquely identify a mobile subscriber unit as a billable entity, each mobile subscriber unit must be assigned a direct dial telephone number, referred to as the Mobile Identification Number (MIN), as well as an equipment identification number, referred to as the Electronic Serial Number (ESN), to enable other subscribers to call this particular mobile subscriber unit and to enable the cell site transmitters to uniquely identify this mobile subscriber unit A among the many that are operational in the service area.

Fraudulent Call Activity - Tumbling

It is obvious that the accurate recordation of call activity is dependent on the ability of the cellular mobile telephone network to uniquely identify each mobile subscriber unit operating within the service area as a billable entity. This goal is easily thwarted by a user who programs their cellular mobile subscriber unit B with the identification assigned by the cellular mobile telephone network to either a valid mobile subscriber unit A operational within the service area or a totally fictitious mobile subscriber unit. Existing cellular telephone systems perform a roaming subscriber validity/authorization

verification after the cellular call is completed. Therefore, the bogus mobile subscriber unit can originate and complete a cellular call without being billed. If the bogus mobile subscriber unit changes
5 or "tumbles" the subscriber number after each call, the existing cellular telephone systems cannot stop the bogus calls unless a tumbling pattern is detected. This bogus mobile subscriber unit B can then initiate cellular calls using the bogus subscriber numbers and
10 existing cellular mobile telephone systems are unable to identify that this bogus mobile subscriber unit B is not authorized to receive service. Tumbling of subscriber numbers is a significant problem in the cellular communication industry and it accounts for
15 significant lost revenues due to the fact that the common carrier cannot be paid for the calls initiated by the bogus mobile subscriber unit. This theft of service is thwarted by the apparatus of the present invention, which detects bogus subscriber units prior
20 to call completion.

Architecture of Tumbling Detection Apparatus

Figures 2 and 3 illustrate in block diagram form the apparatus of the present invention which is used to detect the presence of a mobile subscriber unit B
25 that has been programmed with a bogus subscriber number and to disable such bogus mobile subscriber unit B from receiving communication services in this cellular service area. For the purpose of this invention, it is assumed that this tumbling detection
30 apparatus is located within the roamer verification system 101 noted above. The installation of this tumbling detection apparatus therein provides a greater areal coverage and therefore enables this

tumbling detection apparatus to identify and locate the bogus mobile subscriber unit even though it may roam from one service area to another.

5 This tumbling detection apparatus includes a database that contains information concerning the identity and access telephone number of the plurality of mobile telephone systems located within the service area covered by this particular apparatus. The mobile telephone switching office 102, in response to a call
10 origination from a roaming mobile subscriber unit A, transmits a roaming subscriber validation request to roamer verification system 101 to determine whether the roaming subscriber is authorized to receive service. The mobile telephone switching office 102
15 does not further process this call origination until receiving a positive roamer validation from roamer verification system 101. The roamer verification system 101 scans its database to determine whether roaming subscriber unit A is a valid user, based on
20 the subscriber number transmitted by roaming subscriber unit A. If the subscriber number is not in this database, roamer validation system 101 must determine whether this is a bogus subscriber unit that is tumbling subscriber numbers to fraudulently receive
25 cellular service.

The roamer verification system 101 provides the tumbling detection capability by using a data interface and data links 104, 105 to exchange subscriber and call related data with a plurality of
30 mobile telephone switching offices 102, 103. The roamer verification system 101 includes a subscriber status database (SSDB) which is the single repository for roamer status information. When cellular telephone calls are originated by a roaming

subscriber, the roaming subscriber's identification is checked against the data stored in the subscriber status database to determine whether this is an authorized user. The determination made by the roamer verification system 101 is transmitted back to the mobile telephone switching office that originated the subscriber validation request.

Implementation Details of Cloning Detection Apparatus

Figures 2 and 3 illustrate a portion of the architecture of the roamer verification system 101 that pertains to the tumbling detection capability. The roamer verification system 101 includes, in the preferred embodiment, two processor complexes 201, 202 which provide the computing power necessary to manage the validation and billing of the number of roaming subscribers found in the cellular mobile telephone network. The VPC processor 201 typically consists of a VAX/VMS processor complex manufactured by Digital Equipment Corporation of Maynard, Massachusetts. The VPC processor 201 provides many of the existing roamer validation services, such as the Roaming America service 231 and the Positive Roamer Verification service 233 offered by Appex Corporation as well as operator interface and maintenance software. The VPC processor 201 additionally includes intercarrier settlement services software 236 which records all the billing data for the various service entities that are connected to the roamer verification system 101.

The FTS processor 202 consists of a Stratus SA 2000 fault tolerant processor complex upon which the tumbling detection software is implemented. The FTS processor 202 includes two transaction processing systems: database server system (DSS) 221 and

verification system (VS) 222. The database server system 221 controls access to the subscriber status database 317 and other databases 312 - 316 used by the verification system 222. Verification system 222 provides verification services to mobile telephone switching offices 102, 103 that are served by the roamer verification system 101. The interface between the roamer verification system 101 and the plurality of Mobile Telephone Switching Offices 102, 103 is implemented in the XLI gateway system 203 which is a message handler that simplifies the intercommunication between the various connected entities.

Verification System

The verification system 222 provides roamer verification services for a plurality of mobile telephone switching offices 102, 103. The verification system 222 receives qualification request invokes from Mobile Telephone Switching Offices 102, 103 via an X.25 packet switching network illustrated diagrammatically on Figure 1 as data links 104, 105. Alternatively, intercommunication can be accomplished using the SS7 networking protocol. In either case, upon receipt of a qualification request, the verification system 222 transmits an inquiry to database server system 221 to determine the status of the roaming subscribing unit B which is requesting service in one of the Mobile Telephone Switching Offices (103). The database server system 221 determines the status of the roaming subscriber unit B by retrieving data associated with that designated subscriber unit B from the subscriber status database 317. The retrieved data is then transmitted by database server subsystem 221 to the verification

system 222 wherein a determination is made whether the requesting subscriber unit B is authorized to receive the service it has requested. The verification system 222 accesses routing information from its own internal memory that enables it to respond to the Mobile Telephone Switching Office 102 on either a per NPA-NXX or on a per roaming location basis. Based on the status contained in the subscriber status database, the verification system 222 transmits a qualification request to the Mobile Telephone Switching Office 103 in which the requesting subscriber unit B is presently located. The verification system 222 then determines whether sufficient data is contained in the subscriber status database 317 to make a determination of the authorization of this requesting subscriber unit B. If not, an information request message is transmitted to the home Mobile Telephone Switching Office ex 102 assigned to the requesting subscriber unit B to obtain sufficient subscriber data to make an authorization determination. When the response to this inquiry is received by the verification system 222 it transmits an update to the database server system 221 which accordingly updates the subscriber status database 317 for this requesting subscriber unit B. A complete record of all transaction activity is maintained for both daily and online reporting. If the data collected by verification system 222 indicates that the roaming subscriber unit B is authorized to receive the requested service, an authorization request message is transmitted to the Mobile Telephone Switching Office 103 in whose service area the roaming subscriber unit B is presently located. In response to the received message from the roamer verification system 101, the Mobile Telephone Switching Office 103

provides the requested call connections to subscriber unit B.

Database Server System

5 The database server system 221 provides and controls access not only to the subscriber system database 317 but also to a denial database 313, call detail database 312 and a home switch database 314. The subscriber status database 317 is the single repository of roamer status information for all
10 roaming subscriber units served by the Mobile Telephone Switching Offices 102, 103 connected to the roamer verification system 101. It thereby provides timely access to roamer status information. The database server system 221 also maintains summary
15 statistics on subscriber status database usage for monitoring and reporting purposes. It also maintains a record of all updates made to the subscriber status database 317 on a daily basis.

20 As illustrated in Figure 3, the database server system 221 is comprised of seven functional components:

1. File access component 301.
2. Subscriber summary database server 306.
- 25 3. Subscriber status database server 307.
4. Call detail server 302.
5. Denial server 303.
6. Tumbling server 304.
- 30 7. Daily modification database server 305.

The file access component 301 is the entrance and exit point for all messages destined for the above listed database 302 - 307 servers. Access to the databases
35 312 - 317 within this system occurs directly with the servers 302 - 307 for those files.

File Access Controller

The file access controller 301 is responsible for receiving messages from other processes within the roamer verification system 101 and forwarding them to the appropriate subscriber status database server. The file access controller 301 is also responsible for returning responses to the process that originated the message. It is obvious that within this system there are a plurality of processes that are not described herein that are standard for a database of this type. These processes include additions to the database, modifications to the database, inquiries and updates. For the purpose of simplifying this description, only details concerning detection of tumbled subscriber numbers is presented.

Call Processing

When a roaming subscriber unit B originates a call in one of the cell sites 106 served by a Mobile Telephone Switching Office 103, this is accomplished in well known fashion by roaming subscriber unit B interacting with cell site transmitter 124 to establish a radio frequency link therebetween. Once the radio frequency link has been established between cell site transmitter 124 and roaming subscriber unit B, data messages are transmitted over data link 1124 from cell site transmitter 124 to Mobile Telephone Switching Office 103. Mobile Telephone Switching Office 103 recognizes the request for a call origination and the fact that roaming subscriber unit B is not one of the subscriber units whose home base is Mobile Telephone Switching Office 103. Due to the fact that information concerning roaming subscriber unit B is not contained within the database internal

to Mobile Telephone Switching Office 103, control messages are thereby transmitted by this switching office 103 by data link 105 to roamer verification system 101 to obtain information concerning the authorization of roaming subscriber unit B to originate and receive cellular service. This is accomplished by Mobile Telephone Switching Office 103 transmitting a call detail notification message to the roamer verification system 101. This is received by the XLI gateway system 203 and forwarded to the verification system 221 for processing therein. When the verification system 222 receives a roamer verification request, it transmits a message to the database server system 221 which message contains the following information:

1. Mobile identification number (MIN).
2. Electronic Serial Number (ESN).
3. Roam Switch Identifier.
4. Roam Switch System Identifier.

This same information is also transmitted to the call detail server 303 for entry into the call detail database 313.

Figure 4 illustrates in flow diagram form the operational steps taken by this roamer verification system 101 to identify a bogus call originated by a subscriber. At step 401, the cellular telephone system 103 detects a call origination for a particular cellular subscriber B. As part of the standard subscriber validation process, at step 402 a determination is made whether there is presently an the mobile subscriber unit A that originated this call is a roaming mobile subscriber unit. This determination is typically made at the cellular mobile telephone switching office 102 that receives the call origination. This cellular mobile telephone switching

office reviews the mobile subscriber identification number with a table of authorized subscribers whose home switch is cellular mobile telephone switching office 102. If there is a lack of correspondence
5 between the mobile telephone subscriber unit identification number received from subscriber telephone unit A and the database that is stored in the cellular mobile telephone switching office 102, it is indicative that this is a roaming subscriber
10 requesting service and call processing advances to step 403. If the call origination was from a mobile subscriber unit whose home office was mobile telephone switching office 102, call processing would proceed in a normal fashion as is well known in the art and not
15 described herein. The cellular mobile telephone switching office 102 at step 403 notes the call origination status of mobile subscriber unit A and does not proceed with processing this service request until a positive roamer verification is received from
20 roamer verification system 101. Therefore, the call origination from roaming subscribing unit A is placed on hold at step 403 in the mobile telephone switching office 102 and a roamer validation request message is transmitted to roamer verification system 101 over the
25 data links 105 that interconnect the roamer verification system 101 with this particular cellular mobile telephone switching office 102. Upon receipt of a roamer validation request, roamer verification system 101 at step 405 scans its internal database to
30 determine whether the roaming subscribing unit A is a valid user. This is accomplished by roamer verification system 101 switching the received roamer validation request to verification system 222 for processing. Verification system 222 decodes the

received message and initiates a priority database request since this operation is of a high priority since the call origination is being held by the mobile telephone switching office 102. Database service

5 system 221 receives the priority database scan request from verification system 222 accesses subscriber status database 317 to determine whether the subscriber identification number transmitted to the

10 roamer verification system 101 by the mobile telephone switching office 102 matches any of the authorized subscriber identification numbers stored in subscriber status database 317 at step 405. At step 406, a determination is made whether the roaming subscriber's identification number is stored in the subscriber

15 status database 317. If it is, the roaming subscriber is a valid user and authorized to receive cellular services as a roaming subscriber. At step 407, database server 222 transmits a response to verification system 221 indicative of a positive

20 verification of the identity of the roaming subscriber who is requesting a call origination. The verification system 221 transmits a data message over data link 105 to the cellular mobile telephone switching office 102 serving roaming subscriber A to

25 indicate that this subscriber is a valid user. Cellular mobile telephone switching office 102 in response to the receipt of this message releases the hold placed on this call origination and services this subscriber's request.

30 If, at step 406, this roaming subscriber's identification number is not located in the subscriber status database 317, then either the subscriber is a new roaming subscriber unit or it's possibly a bogus subscriber unit which is using number tumbling as a

method of fraudulently obtaining services. In order to resolve this status ambiguity with regard to roaming subscriber unit A, at step 408, roamer validation system 101 accesses a database contained therein which lists the identity of each cellular mobile switching office served by roamer validation system 101. Associated with each identified cellular mobile switching office entry is data indicative of the type of system used to implement this switching office as well as the message format required to communicate therewith and access data to identify a communication path from roamer verification system 101 to the identified switching office. At step 409, verification system 222 translates the subscriber identification number to a cellular mobile switching office identification which is then used to access the data record stored in this database associated with the identified cellular mobile switching office. At step 410, the retrieved data record is used to formulate a roamer validation request message in the format required by the home switching office of the roaming subscriber. At step 411, a data connection is originated by verification system 222 over data link 105 to the identified home switching office using the data connection information retrieved from the database. Once the data connection is established with the home switching office, the formatted roamer validation request message is transmitted to this home switching office in order to determine whether this subscriber unit is a valid subscriber. The home switching office upon receipt of the roamer validation request from the roamer verification system 101 scans its subscriber database to determine whether this subscriber identification number is a valid user

number or a bogus number. At step 412, the response is received from the home switching office at roamer verification system 101 and decoded in order to determine whether the home switch has identified this roaming subscriber unit as a valid subscriber. At step 413 the determination is made whether this roaming subscriber unit is valid or bogus. If a positive determination is made that the roaming subscriber unit is a valid subscriber, the roamer verification system 101 at step 415 transmits a data message to the serving mobile switch 102 to indicate that it is authorized to provide the requested service to the roaming subscribing unit A. If however a positive subscriber identity verification has not been received from the home switch nor obtained from the roamer verification system 101 database, a message is transmitted by the roamer verification system 101 at step 414 to the serving mobile telephone switching office indicative of the lack of a positive roamer verification at which point the cellular mobile switching office 102 denies service to this roaming subscriber unit and presumes that this a bogus unit attempting to fraudulently obtain service. The serving cellular mobile telephone switching office 102 therefore denies service to this bogus unit.

By performing the subscriber identification number validation on every call origination prior to providing the requested service, tumbling fraud can be eliminated since every bogus number will be identified prior to providing the subscriber unit with any service. The speed of operation of the roamer verification system 101 is enhanced by the use of the home switching office look up table which allows the rapid creation, formatting and transmission of data

messages between the roamer verification system 101 and the home switching office for each subscriber unit that is not already catalogued in the database contained within the roamer verification system 101.

5 The operation of the roamer verification system 101 is maintained at a high level of responsiveness since the data comparison that must be performed is a matching of the MIN/ESN to entries in the database. The simple
10 existence of a matching subscriber identification number is all that is required to positively identify the mobile subscriber unit as a valid unit. This simple mapping of the input subscriber identification number to table entries without requiring the access to the data record associated with these entries
15 enables the roamer verification system 101 to process a significant number of requests in real time without delaying the provision of service to the subscriber units.

20 While a specific embodiment of this invention has been disclosed, it is expected that those skilled in the art can and will design alternate embodiments of this invention that fall within the scope of the appended claims.

I CLAIM:

1. In a cellular mobile telephone system, wherein a plurality of mobile telephone switching offices (102, 103), each of which serves a plurality of cell sites (12*, 13*) for establishing cellular
5 call connections with mobile subscriber units (A, B) located in a geographical area covered by said cell sites (12*, 13*), are connected to a subscriber verification system (101) which validates the authorization of subscriber units (A, B), each of
10 which is identified by a unique subscriber identification code assigned to said subscriber unit (A), to receive service when roaming outside of the subscriber's home mobile telephone switching office (103), apparatus in said subscriber verification
15 system (101) to detect subscriber identification code tumbling comprising:

database means (317) for storing data indicative of subscriber unit identification codes of mobile subscriber units (A) authorized to receive
20 service in a mobile telephone switching office (103);

means (317, 401-405), responsive to a roaming subscriber unit (A) originating a cellular call connection in one of said mobile telephone switching offices (102), for storing a subscriber unit
25 identification code assigned to said roaming subscriber unit (A);

means (406) for determining a correspondence between said subscriber unit identification code of said roaming subscriber and said stored data;

30 means (233, 408-411), responsive to a lack of correspondence between said subscriber unit identification code of said roaming subscriber and

said stored data, for transmitting a roamer validation request message to said roaming subscriber's home mobile telephone switching office (103); and
35 means (412-413, 415), responsive to a receipt of a message from said roaming subscriber's home mobile telephone switching office (103) validating the identity of said roaming subscriber,
40 for authorizing the provision of service to said roaming subscriber.

2. The apparatus of claim 1 wherein said authorizing means (412-413, 415) includes:

means (415) for transmitting a message to said one mobile telephone switching office (102) to
5 identify said roaming subscriber as a valid subscriber.

3. The apparatus of claim 2 further comprising:
means (403, 414) for blocking the provision of service to said roaming subscriber absent said message identifying said roaming subscriber as a valid
5 subscriber.

4. The apparatus of claim 1 further comprising:
means (401-404), responsive to a roaming subscriber unit (A) originating a cellular call connection in one of said mobile telephone switching
5 offices (102), for transmitting said subscriber unit identification code assigned to said roaming subscriber unit (A) to said storing means (317, 401-405).

5. The apparatus of claim 1 further comprising:
means (410) for listing a correspondence

between each of said plurality of mobile telephone switching offices (102, 103) and a roamer validation request message format.

6. The apparatus of claim 5 wherein said transmitting means (233, 408-411) includes:

means (408, 409) for identifying said roaming subscriber's home mobile telephone switching office (103) from said subscriber unit identification code assigned to said roaming subscriber unit (A).

7. The apparatus of claim 6 wherein said transmitting means (233, 408-411) further includes:

means (409), responsive to the identification of said roaming subscriber's home mobile telephone switching office (103), for retrieving said roamer validation request message format corresponding to said identified home mobile telephone switching office (103) from said listing means (410).

8. The apparatus of claim 7 wherein said transmitting means (233, 408-411) further includes:

means (410) for populating said retrieved message format with said roaming subscriber unit identification code; and

means (411) for establishing a data connection to said identified home mobile telephone switching office (103) to transmit said populated message format.

9. The apparatus of claim 1 further comprising:

means (412-414), responsive to a receipt of a message from said roaming subscriber's home mobile

5 telephone switching office (103) failing to validate the identity of said roaming subscriber, for denying the provision of service to said roaming subscriber.

10. The apparatus of claim 9 wherein said authorizing means (412-413, 415) includes:

5 means (414) for transmitting a message to said one mobile telephone switching office (102) to identify said roaming subscriber as a bogus subscriber.

11. In a cellular mobile telephone system, wherein a plurality of mobile telephone switching offices (102, 103), each of which serves a plurality of cell sites (12*, 13*) for establishing cellular
5 call connections with mobile subscriber units (A, B) located in a geographical area covered by said cell sites (12*, 13*), are connected to a subscriber verification system (101) which^o validates the
10 authorization of subscriber units (A, B), each of which is identified by a unique subscriber identification code assigned to said subscriber unit (A), to receive service when roaming outside of the subscriber's home mobile telephone switching office (103), a method in said subscriber verification system
15 (101) to detect subscriber identification code tumbling comprising the steps of:

storing data indicative of subscriber unit identification codes of mobile subscriber units (A) authorized to receive service in a mobile telephone
20 switching office (103);

storing, in response to a roaming subscriber unit (A) originating a cellular call connection in one of said mobile telephone switching offices (102), in

a memory (317) a subscriber unit identification code
25 assigned to said roaming subscriber unit (A);
determining a correspondence between said
subscriber unit identification code of said roaming
subscriber and said stored data;
transmitting, in response to a lack of
30 correspondence between said subscriber unit
identification code of said roaming subscriber and
said stored data, a roamer validation request message
to said roaming subscriber's home mobile telephone
switching office (103); and
35 authorizing, in response to a receipt of a
message from said roaming subscriber's home mobile
telephone switching office (103) validating the
identity of said roaming subscriber, the provision of
service to said roaming subscriber.

12. The method of claim 11 wherein said step of
authorizing includes:

transmitting a message to said one mobile
telephone switching office (102) to identify said
5 roaming subscriber as a valid subscriber.

13. The method of claim 12 further comprising
the step of:

blocking the provision of service to said
roaming subscriber absent said message identifying
5 said roaming subscriber as a valid subscriber.

14. The method of claim 11 further comprising
the step of:

transmitting, in response to a roaming
subscriber unit (A) originating a cellular call
5 connection in one of said mobile telephone switching

offices (102), said subscriber unit identification code assigned to said roaming subscriber unit (A) to said memory (317).

15. The method of claim 11 further comprising the step of:

listing in said memory (317) a correspondence between each of said plurality of mobile telephone switching offices (102, 103) and a roamer validation request message format.

16. The method of claim 15 wherein said step of transmitting includes:

identifying said roaming subscriber's home mobile telephone switching office (103) from said subscriber unit identification code assigned to said roaming subscriber unit (A).

17. The method of claim 16 wherein said step of transmitting further includes:

retrieving, in response to the identification of said roaming subscriber's home mobile telephone switching office (103), said roamer validation request message format corresponding to said identified home mobile telephone switching office (103), from said memory (317).

18. The method of claim 17 wherein said step of transmitting further includes:

populating said retrieved message format with said roaming subscriber unit identification code; and

establishing a data connection to said identified home mobile telephone switching office

(103) to transmit said populated message format.

19. The method of claim 11 further comprising the step of:

denying, in response to a receipt of a message from said roaming subscriber's home mobile telephone switching office (103) failing to validate the identity of said roaming subscriber, the provision of service to said roaming subscriber.

20. The method of claim 19 wherein said step of authorizing includes:

transmitting a message to said one mobile telephone switching office (102) to identify said roaming subscriber as a bogus subscriber.

FIG. 2.

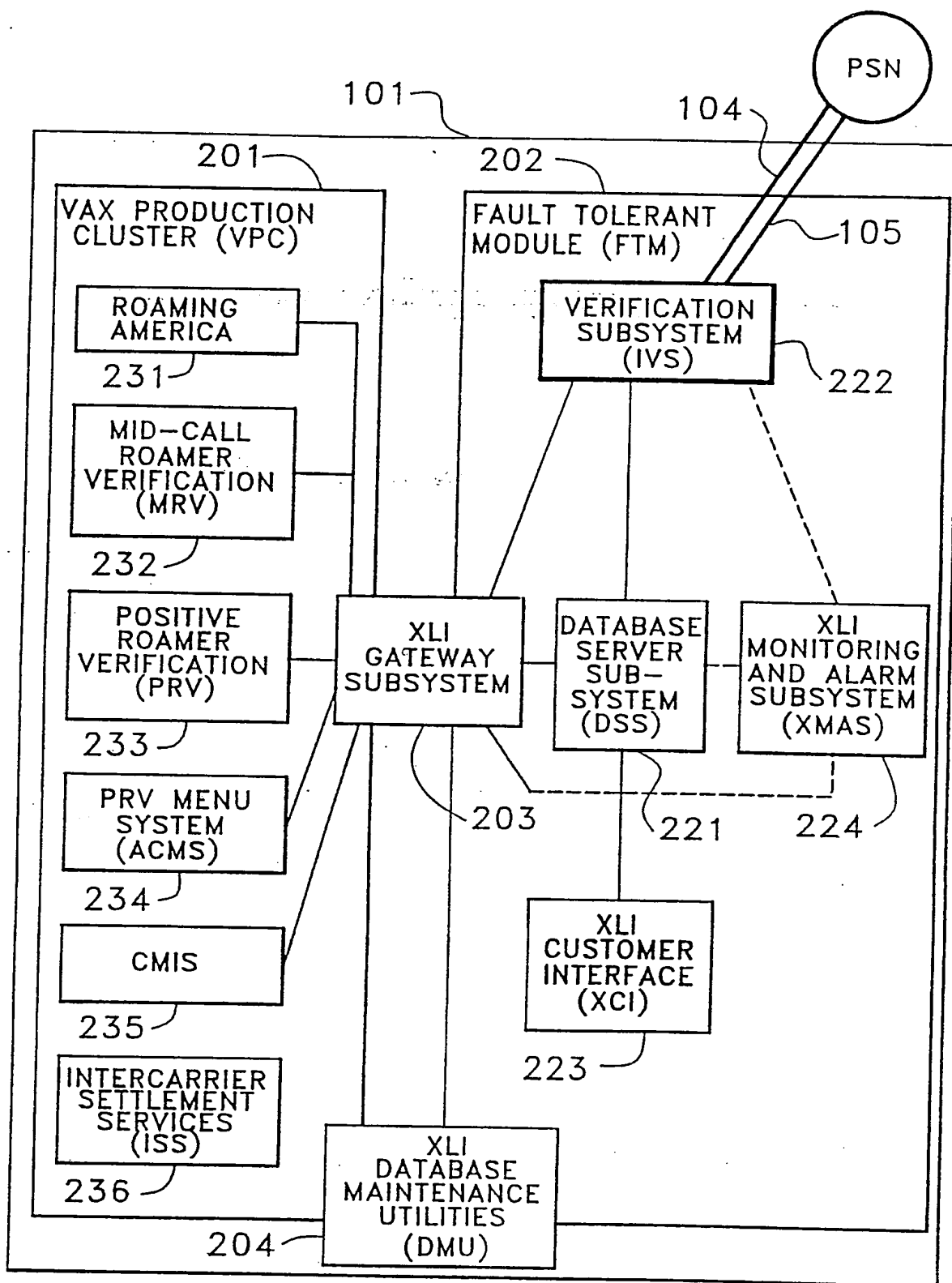
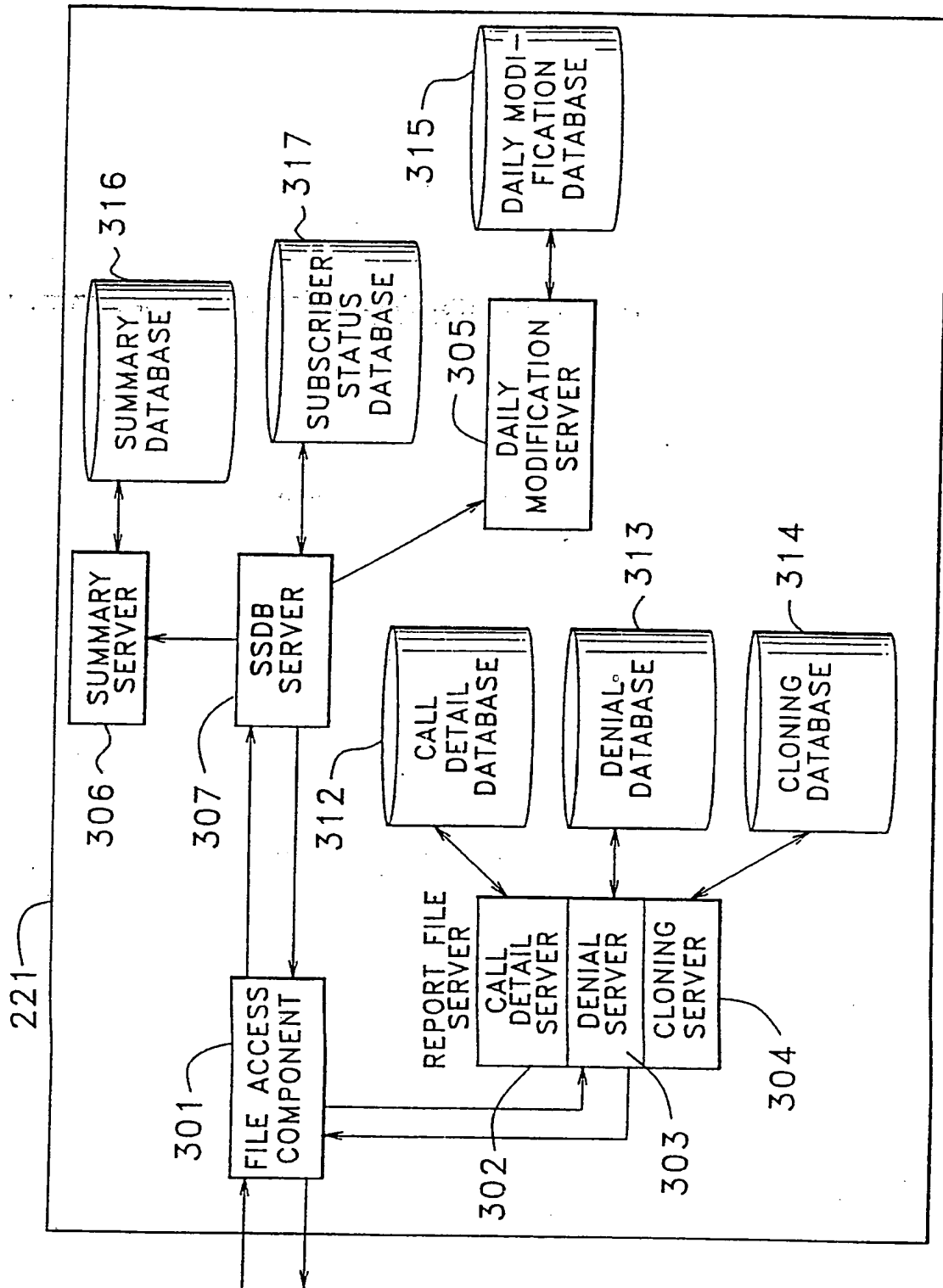


FIG. 3



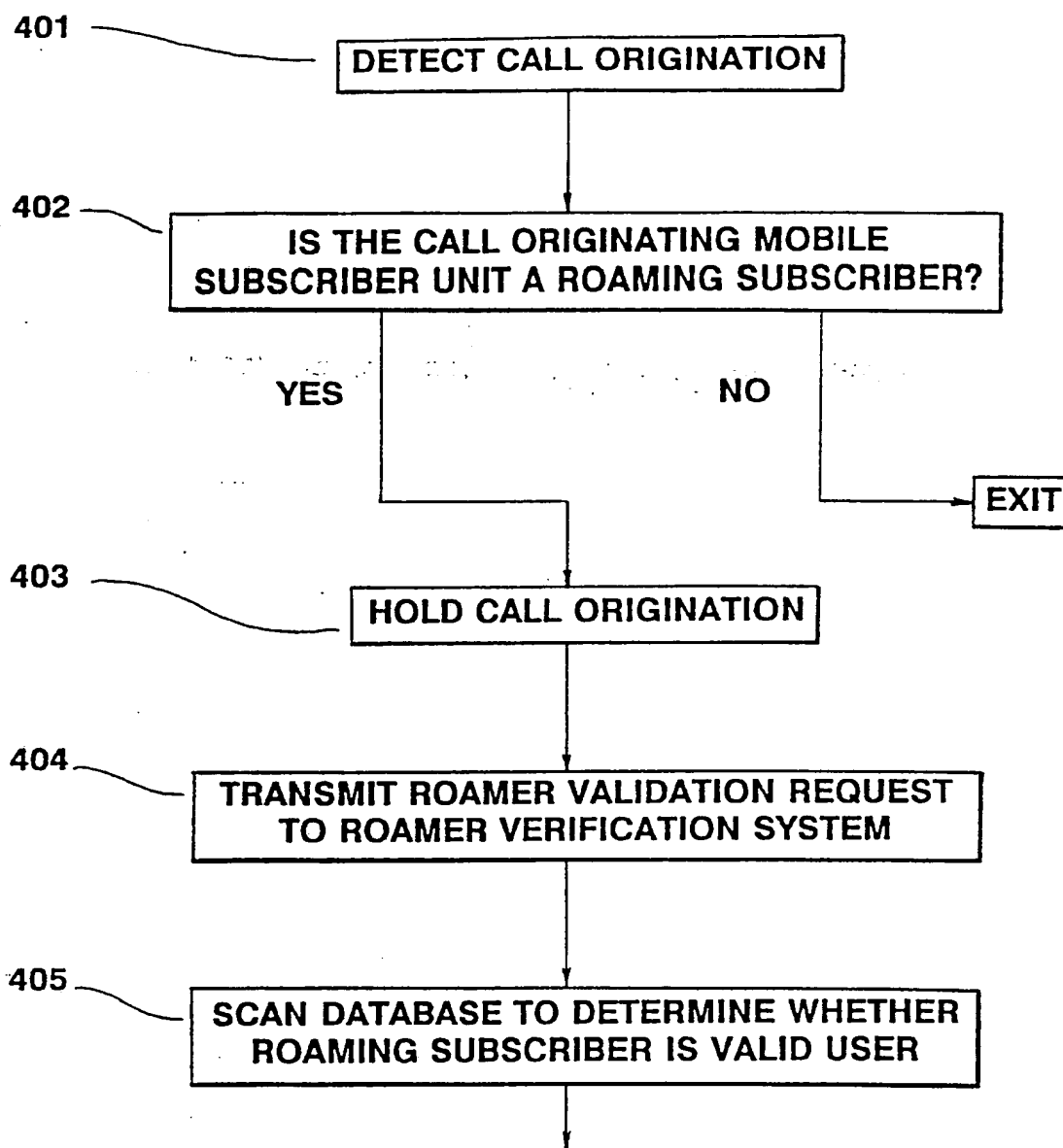


FIGURE 4

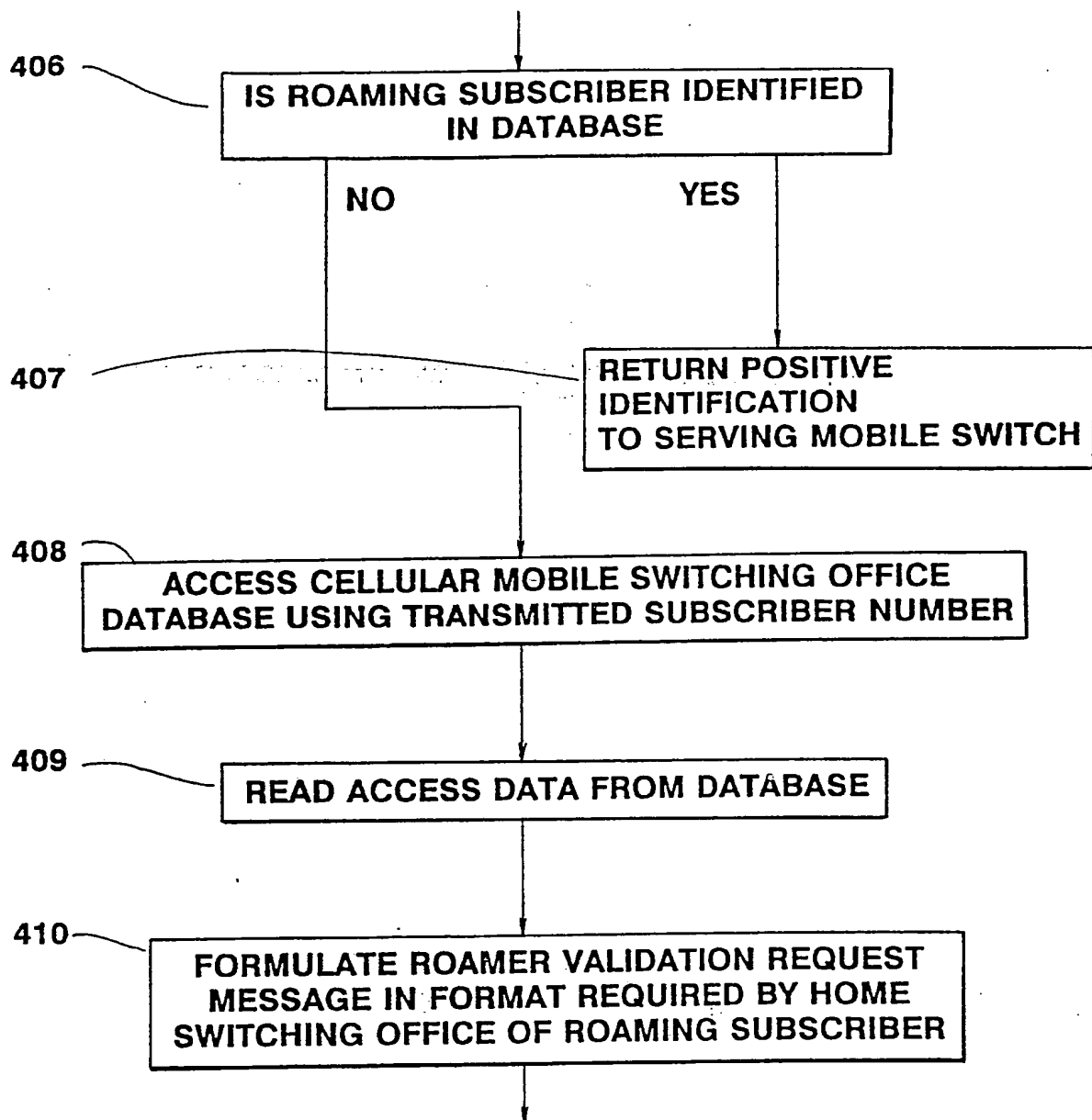


FIGURE 5

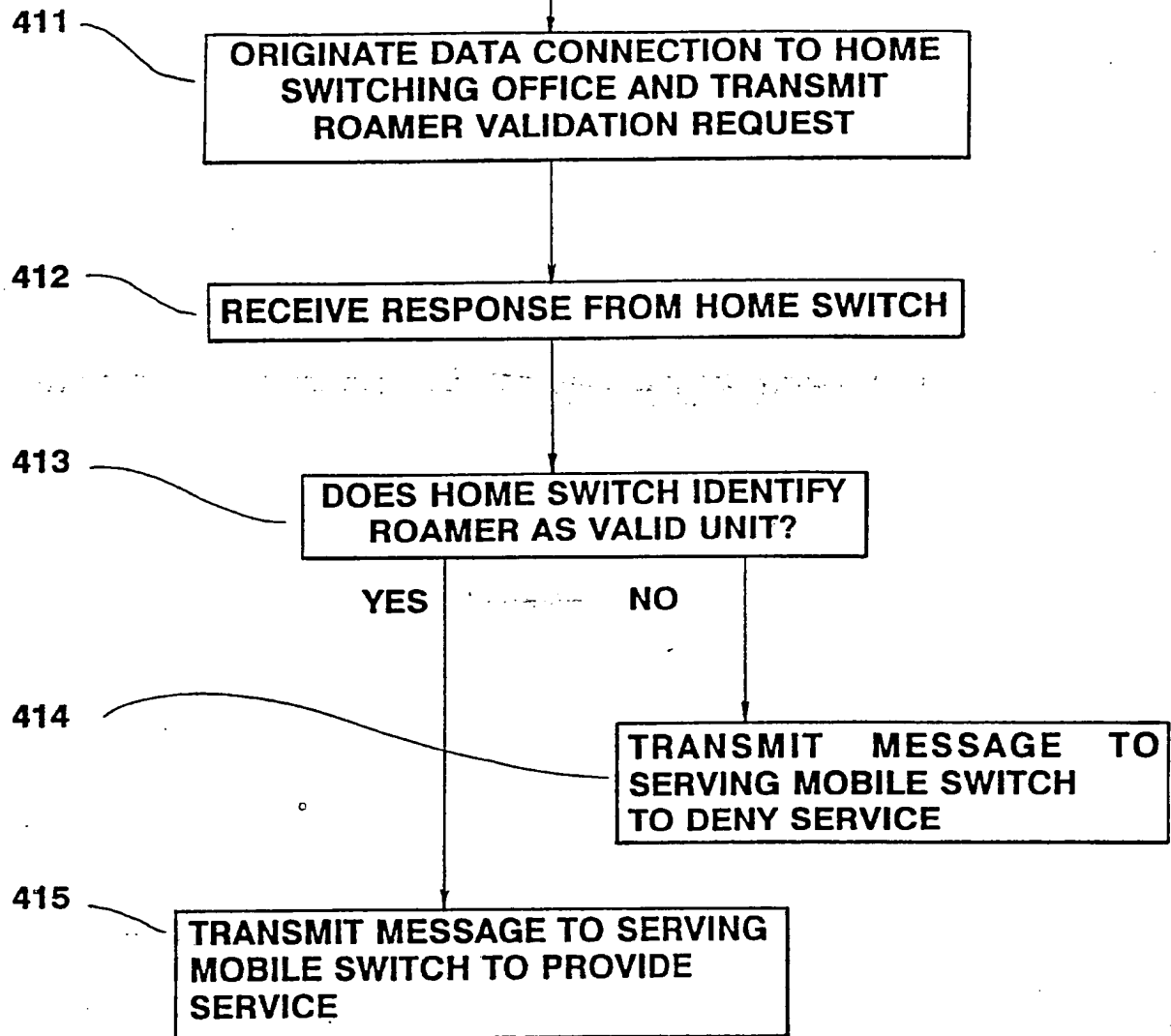


FIGURE 6

INTERNATIONAL SEARCH REPORT

PCT/US 92/10198

International Application No

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) ⁶		
According to International Patent Classification (IPC) or to both National Classification and IPC		
Int.Cl. 5 H04Q7/04		
II. FIELDS SEARCHED		
Minimum Documentation Searched ⁷		
Classification System	Classification Symbols	
Int.Cl. 5	H04Q	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched ⁸		
III. DOCUMENTS CONSIDERED TO BE RELEVANT⁹		
Category ¹⁰	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³
A	EP,A,0 379 642 (GTE MOBILNET INC.) 1 August 1990 see page 4, line 50 - page 5, line 19 see page 6, line 9 - line 21 see page 6, line 58 - page 7, line 8 see page 7, line 39 - line 47 see page 12, line 26 - line 37 see page 14, line 25 - line 32 see page 15, line 18 - line 39 see page 46, line 56 - page 47, line 2 see page 51, line 40 - page 52, line 32 ---	1,11
A	39TH IEEE VEHICULAR TECHNOLOGY CONFERENCE vol. 1, 1 May 1989, SAN-FRANCISCO (US) pages 1 - 6 K.W. KACZMAREK 'Cellular Networking: A Carrier's Perspective' see page 2, right column, line 1 - page 3, left column, line 6 --- -/-	1,11
<p>¹⁰ Special categories of cited documents:</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"&" document member of the same patent family</p>		
IV. CERTIFICATION		
Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report	
08 MARCH 1993	1 1. 03. 93	
International Searching Authority	Signature of Authorized Officer	
EUROPEAN PATENT OFFICE	GERLING J.C.J.	

III. DOCUMENTS CONSIDERED TO BE RELEVANT

(CONTINUED FROM THE SECOND SHEET)

Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
A	<p>41ST IEEE VEHICULAR TECHNOLOGY CONFERENCE 19 May 1991, ST. LOUIS (US) pages 393 - 398 J. NGUYEN ET AL 'Personal Communications Service - Concept and Architecture' see page 393, left column, line 33 - page 394, right column, line 32 see page 394, left column, line 20 - page 395, right column, line 19 see page 395, left column, line 56 - right column, line 42</p> <p>-----</p>	1, 11

**ANNEX TO THE INTERNATIONAL SEARCH REPORT
ON INTERNATIONAL PATENT APPLICATION NO.**

US 9210198
SA 67923

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on the above-mentioned patent document. The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

08/03/93

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP-A-0379642	01-08-90	US-A- 4901340	13-02-90